or mean tone temperament, a *small* semitone has $4\frac{1}{2}$, a *large* one 7, and a tone 12 per cent. more vibrations. These numbers are very convenient for rough estimations.

The old French foot is 6 per cent. longer than the English, hence the one-foot pipe will be a semitone lower than the English, or about 443 to 446 vibrations. I have not met with a case of a French organ with A 443, or the one-foot pipe on A. But *Mersenne*, 1636, places the one-foot pipe on G, and this gives mean-tone A 496 and C 593. Now the St. Jacobi organ had actually A 491 and C 584 (equal temperament, making the C lower), as determined by forks tuned to the pitch and then measured. Hence, Mersenne's pitch, which even M. Cavaillé-Coll considered must be a mistake, actually exists at the present day.

2. The B flat foot organ, or B flat 472 to 475. This gives A 442, C 528, on the mean-tone temperament, that is, actually the pitch desired by the Society of Arts and not attained. This pitch was used by *Thomas Harris* in the Worcester Cathedral organ of 1666, by *Berhard Schmidt* (or Father Smith, as he has been called), in Durham Cathedral, 1683, Hampton Court, 1690, St. Paul's Cathedral, 1694-7, Trinity College, Cambridge, 1708, as I have ascertained, and probably in all his organs. It seems to have been occasionally used by the *Jordans*, who seem also to have built an A foot organ; but my inquiries are not yet complete. It is the favourite pitch of modern English organ builders, as I have ascertained by measuring the pitch-pipes of seven of the principal builders in London, which vary from C 524 to 528, at 60° F., to which all pitches are reduced.

3. The B foot organ, or B 472 to 475. This gives in England A 422 to 425, and C 506 to 512. This pitch was in general use, from at least 1700 to 1820, over England and over Germany. I found it in *Renatus Harris's*, All Hallows, Barking, 1675-7; St. Andrew Undershaft, 1696; and St. John's, Clerkenwell (date unknown); in *Harris and Byfield's*, St. Mary's, Shrewsbury; in *Byfield, Jordan, and Bridge's* two Great Yarmouth organs, 1733-40; in *Byfield and Green's*, St. Lawrence, Reading, 1771, and St. Mary's, Islington, 1772; in *Glyn and Parker's*, All Hallows the Great, Thames Street, 1749; in *Schnetzler's*, German Chapel Royal, St. James's Palace (date uncertain); in *Green's*, St. George's Chapel, Windsor, 1790; Winchester College Chapel, 1780; St. Katherine's, Regent's Park, 1778; and Kew Parish Church (date unknown). Glyn and Parker built the organ which Handel gave to the Foundling Hospital, 1750, and Handel, after conducting a performance of the "Messiah" there, in 1751, left his tuning-fork behind him. This fork is now in the possession of Rev. G. T. Driffield, Rector of Bow, and shows A 423, which is presumably the pitch of that organ. Mozart's clavier-maker, Stein, at Vienna, 1780-90, used a fork one vibration lower, A 422, which was undoubtedly the pitch of Haydn and Beethoven, and hence of Church music generally. It is a quarter of a tone flatter than French pitch. This was the pitch used when the Philharmonic Society was started in London, 1813, and was retained to 1826. Silbermann's organ at the Roman Catholic Church, Dresden, was about a comma flatter, or A 415.

4. The C foot-organ, or C 472 to 475 and A 495. The only instance known to me in England is Trinity College, Cambridge, as recorded in 1759 by the celebrated Dr. Robert Smith, its master, in his "Harmonics." But this was after its pitch (which was originally that of a B flat foot-organ) had been lowered a mean tone, by shifting the pipes, which, as he tells us, made it agree with the Roman pitch-pipes of 1702. But the French foot being a semitone flatter than the English, the Versailles B foot-organ (1786) had a pitch of A 396, C 474, as shown by the fork preserved in the Conservatoire in Paris, and hence precisely agreed with the altered Trinity College organ and the Roman pitch-pipe. Delezenne, in 1854, was fortunate enough to find an old dilapidated organ at the Hospice Comtesse, near Lille, which gave C 448, as near as he could measure, agreeing well with C 443, the calculated pitch of the French C foot organ.

This seems to be the first attempt at systematically finding the pitch of organs. The pitch of the pipes was in all cases found, when they could be actually heard, by beats with tuning-forks made for me, to the extent of an octave, on the basis of Scheibler's 256, 435, 440 (which I have reason to believe perfectly accurate), by Valantine and Carr, 76, Milton Street, Sheffield, and I have also reason to believe that these latter forks are not more than half a vibration wrong with Scheibler in any case. But before my complete paper is ready I shall have verified them by eighteen other forks of Scheibler now being very carefully copied at Crefeld. To hear the beats I stand thirty or forty feet away from the organ, and hold the fork over a resonance jar tuned to its pitch by pouring in water. The bellows is first filled, and no pumping is allowed during the ten seconds that I count. The beats are beautifully distinct, and I consider the result to be correct within one-fifth of a vibration.

The correction for temperature, which is most important (as at C 500 it is more than half a vibration per degree Fahr., to be added for higher and subtracted for lower temperature), is found by the following rule:—Add four per cent. to the number of vibrations observed, divide result by 1,000, and multiply by the number of degrees required. I have thus harmonised measurements made between 73° and 45° F.

The rule for finding pitch from measurement was given by M. Cavaillé-Coll (*Comptes Rendus*, 1860, p. 176), and, reduced to English measures, is as follows:—

Let L be the length, in English inches, of an open flue cylindrical metal diapason from the lower lip to the open end, and D its internal diameter, also in inches. The latter measure is frequently difficult to make, on account of the jagged, or "coned," or compressed, extremity. Then use the outer circumference, by wrapping a piece of paper round the pipe where it is truly circular; calculate the diameter as $\frac{7}{22}$ circumference, and throw off $\frac{1}{20}$ inch for the thickness of the pipe, to find D, which has to be known with considerable accuracy.

Let V be the number of double vibrations in the pipe, at 60° F., then

$$V = \frac{20080}{3L + 5D}.$$

I tried this formula with a whole octave of pipes at Green's St. Katherine's organ, and found that the error rarely reached one comma (or 1 in 80), which many persons can't hear, and never reached two commas (or 1 in 40). Since a quarter of a tone is 3 per cent. (or 1 in $33\frac{1}{3}$), and a semitone is 6 per cent. (or 1 in $16\frac{2}{3}$), this gives a far better knowledge than we can obtain by ordinary estimation of ear, without counting beats by measured forks.

It would confer a great favour on me if any one could give me these dimensions of old, unaltered organ pipes for the pipe which is nearest to twelve English inches in length, anywhere, especially abroad, naming the place and the note, and, if possible, date and builder, or would point out any existing unaltered old organs.

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The Formation of Mountains

MR. ALFRED R. WALLACE asks one of our "great" physicists to enlighten us about the possibility of the interior of the globe "cooling more rapidly than the crust." If he will turn to a chapter on Conduction in such a work as Maxwell's "Theory of Heat," he will find an explanation of the principle. At p. 247 is a passage especially relating to the loss of heat by the earth.

But perhaps even a little physicist may help our great naturalist as the mouse did the lion.

In the first place it is of course understood that whenever it is said that "the interior of the globe cools more than the crust," it is not meant that it ever becomes cooler than the crust, but only that the interior, from age to age, goes on getting cooler than it was before, whilst the crust keeps at nearly a constant temperature.

An illustration, which I think gives a good idea of this process, may be taken from the dispersion of a crowd of persons in the street. Suppose each person to represent a certain quantity of heat. Then the number of persons in any space may be considered to represent its temperature, so that the crowded part will represent a very hot space. As the people disperse they move off the more quickly the further they get from the dense mass.

Now draw two lines near together across the street at some small distance from the densest part of the crowd, and let the space between these two lines represent the crust of the earth, while the space occupied by the crowd represents the earth's interior, and all beyond the outer line represents infinite space. Then the number of people passing outwards between the two lines at any particular moment will represent the quantity of heat in, and so the temperature of, the crust. At the

same time the number of persons remaining in the crowd will represent the quantity of heat in, and so the temperature of, the interior. Then it will be obvious that as the crowd disperses the number of persons at any one time between the lines may continue about the same (although the individuals will be changed), whilst those in the central crowd become fewer and fewer. This illustrates how the temperature of the crust may continue nearly uniform in spite of the continued loss of heat from, and cooling of, the interior.

I believe that I have long ago proved that the mere cooling of a solid earth would not give the amount of contraction needed to account for the observed inequalities of the surface, and I surmise that a diminution of the earth's volume has been caused by the escape of steam and gases from volcanic vents during past ages. This view has, however, attracted more attention in America than at home. O. FISHER

Harlton, Cambridge, December 13

Magnetic Storm, May 14, 1878

I AM inclined to think that Mr. Mance's observations (vol. xix. p. 148) upon the earth currents observed at Kurrachee must be incorrectly reported. To agree with the observations in China, Stonyhurst, Greenwich, and Haverfordwest, they should have commenced at 4 A.M. on May 15, and terminated at 5 P.M. on the same day (Kurrachee time).

It is a pity that electricians do not record these currents in absolute units. To say that the current was equal to fourteen Daniell cells means nothing unless the resistances present are also given. If an earth current is observed upon a cable it is easy to reproduce this current upon the same galvanometer with a known resistance and a known electromotive force, and then to express its value in webers or milliwebers. Thus if at Kurrachee 50° were noted on a galvanometer, and one Daniell cell reproduced this deflection through a total resistance of 125 ohms, then the current would be equal to $\frac{1}{125}$, or ·008 weber or 8 milliwebers, a magnitude which every electrician would understand. Moreover, if the length, resistance, and general direction of the cable or wire were given, as well as the direction of the current itself, the difference of potential of the earth at the two ends would be known. This if the cable were 246 miles long, and lay due east and west, and its resistance were 5ω per mile, then in the above case

$$\frac{E}{1230} = \cdot 008$$
$$E = 9 \cdot 84 \text{ volts},$$

which is the difference of potential of the two ends.

If simultaneous observations were made in this way at numerous stations on the earth's surface, we should be able to plot out the distribution of potential on the globe, and arrive at some better knowledge of the cause of earth-currents than we have at present. W. H. PREECE

December 20

The Derivation of Life from the North

ATTENTION has been called by the President of the Royal Society to the labours of Mr. Dyer, as pointing in the case of plants to the conclusion that their various forms have been developed and dispersed from the north. I presume it is recognised that similar conclusions have been arrived at by Mr. A. R. Wallace in the case of animals. Mr. Wallace points to the palæarctic region as the great centre of their development or creation. On reading "The Geographical Distribution of Animals" when it first appeared, I was so much struck with the evidence adduced, that I was tempted to write and ask him if his work might not be said to occupy the following position in the history of unravelling what was formerly the mystery of geographical distribution. Mr. Darwin and others, including Mr. Wallace himself, had found a causal nexus in the case of islands, had shown that the faunas of islands had been derived from that of the nearest mainland, and in a character and degree varying concomitantly with the degree of their present disconnection therewith. They had thus completed the necessity for "centres of creation." Did not "The Geographical Distribution of Animals" afford the requisite evidence for carrying this commencement to its logical conclusion: for showing that in their turn the great continents themselves, or, more precisely, those which are outlying to the central mass (which is in the north, around the Pole), have a similar dependence, and have borrowed their own faunas from that northern mass, in a character and degree proportional to the dates and degree of their connection or separation from it, the islands might then be said to be the satellites, and the great zoological regions the planets of this system, all having borrowed their life directly or indirectly from a *single* "centre of creation."

To render this still clearer to my own mind I had a map of the world designed on a polar projection, the northern hemisphere being projected to somewhat beyond the southern tropic. By this means the manner in which the land surface of the globe is built around the pole is clearly seen, and the extremities of America, Africa, and Australia, extending into the great oceans of the world, are embraced, or nearly so. When the subdivisional regions (zoologically) of each of these great projections, and of the whole, are marked in colours, a succession of zoological strata, to speak rather inaccurately, appears. By carrying an ideal section from the supposed centre of creation in the north through either of these three great extremities, and from thence to the nearer, and afterwards the more remote, dependencies of those extremities (remote not in point of actual distance, as in degree of connection), we pass in each case through zoological strata of different types, until we arrive at those where no land-mammals are to be found at all. And this succession in space, as evidenced by geography, corresponds in a rough way with the succession in time, as revealed by geology. 1. As we recede in distance we meet with increased dissimilarity. 2. This dissimilarity partakes of a recession in type. 3. Some of these geographical districts seem to have their counterparts in geological periods. The Ethiopian region, as Mr. Wallace shows, presents us with the exiled miocene fauna of Europe in the most striking manner. Eocene forms may be seen in its dependency of Madagascar, or in the West Indies. Highly isolated Australia with its marsupials, &c., appears as if it were still in the secondary age. Oceanic islands, such as New Zealand, with a more beautiful climate, and more extensive surface than Great Britain, give us no land mammals at all. In others the reptiles "possess the land."

Mr. Wallace's plan is an excellent illustration of the comparative method, and shows how a careful classification leads to the solution of historical questions connected with the causes of that classification. Those causes are in this case comprised in the inference that a succession of waves of life has been propagated from the north, not all of which have had an equal extension, nor all encountered similar modifying circumstances.

If these inferences are not correct, perhaps Mr. Wallace would kindly set me right. J. W. BARRY

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Glaciation of the Italian Lakes

HAVING spent some time lately on the border-land between Switzerland and Italy, it has occurred to me that a note on some glacial features of that region may prove of interest to the readers of NATURE.

The Lake of Lugano is a rock-basin. I believe it to have been scooped out by the glaciers which have formerly descended from the Alps. Of this there is abundant proof. The crystalline rocks in their lower reaches possess the easily recognisable outlines of *roches moutonneés*, but the stratified mesozoic rocks have lost these characters. Above Lugano and Agno these features are very well marked, and in these localities striation is tolerably frequent, the direction of the striæ being southerly. Along both sides of the southern extension of Mount St. Salvatore to Moreate, striæ can be seen in a few places near the lake-level, and the same is the case on both the Pianbello and Generoso shores. At the southern extremities of the lake are abundant moraine-mounds. Erratics are also present, most being gneissose or granitic, but a few have fallen upon the moving ice from nearer localities, as they are of dolomite. The moraine masses are cut through by the northerly flowing streams, but, after passing the parting between the waters flowing towards Lake Lugano and those running into Lake Como, there is the appearance of great destruction of the moraines. Unfortunately I had a mere cursory glance down the Val della Tresa, through which the drainage of the lake flows to Lago Maggiore. It has often been remarked that in this South Alpine lake district, the *débris* left by the glaciers is exceedingly small when contrasted with similar regions north of that moun-